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This survey of existing Deputy for Engineering (EN) facilities revealed a number of deficiencies that impede EN's ability to meet current mission requirements. The dispersion of EN organizations into 12 separate buildings reduces technical information transfer and innovation. Conditions of several buildings is inadequate for housing expensive electronic equipment. Existing floor space is not adequate is several facilities, causing delays in scheduling, engineering tests and other EN mission activities. The situation will grow worse as EN mission requirements expand in the future. Survey results justify

(over)

ASSESSMENT OF EXISTING DEPUTY FOR ENGINEERING FACILITIES

ADA 134928

September 1982

James M. Baker
Paul F. Dienemann

Prepared pursuant to Department of Defense Contract No. MDA 903-81-C-0166 (Task AF202).

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CHAPTER 1. INTRODUCTION

The Deputy for Engineering (EN) Aeronautical Systems Division (ASD), provides system engineering, technical direction, and engineering management support to System Program Offices (SPOs) and other ASD organizations at Wright-Patterson Air Force Base (WPAFB). As of August 1982, the EN organization has approximately 1,618 authorized military and civilian personnel, 48 percent of whom are collocated with the SPOs or other organizations they support. Fifty percent of all authorized scientist and engineer personnel are collocated. The others (home-office personnel) occupy, in part or in whole, twelve buildings in Area B of WPAFB as shown in Figure 1-1.

EN presently comprises 62 organizational units organized into three functional directorates: avionics engineering (ENA) with 493 employees, equipment engineering (ENE) with 418 employees, and flight systems engineering (ENF) with 453 employees and two offices: systems engineering (ENS) with 129 employees and engineering operations (ENO) with 117 employees. All report to the Deputy for Engineering (8 employees) as shown in Figure 1-2.

Current EN management plans are for the systems engineering office (ENS) to expand into a new directorate within the next year. This new directorate will provide systems integration and develop descriptions of system functions, performance and configuration. Some modest reorganization of the present EN directorates and additional hiring of EN personnel are expected.

A Systems Integration Facility (SIF) has been proposed to provide full-scale man-in-the-loop simulation capability for aircraft weapon system development. Originally a joint ASD/Air Force Laboratories submittal in the FY84 Military Construction program, SIF is now incorporated within the EN facility project.

FIGURE 1-1 SITE MAP OF EN FACILITIES

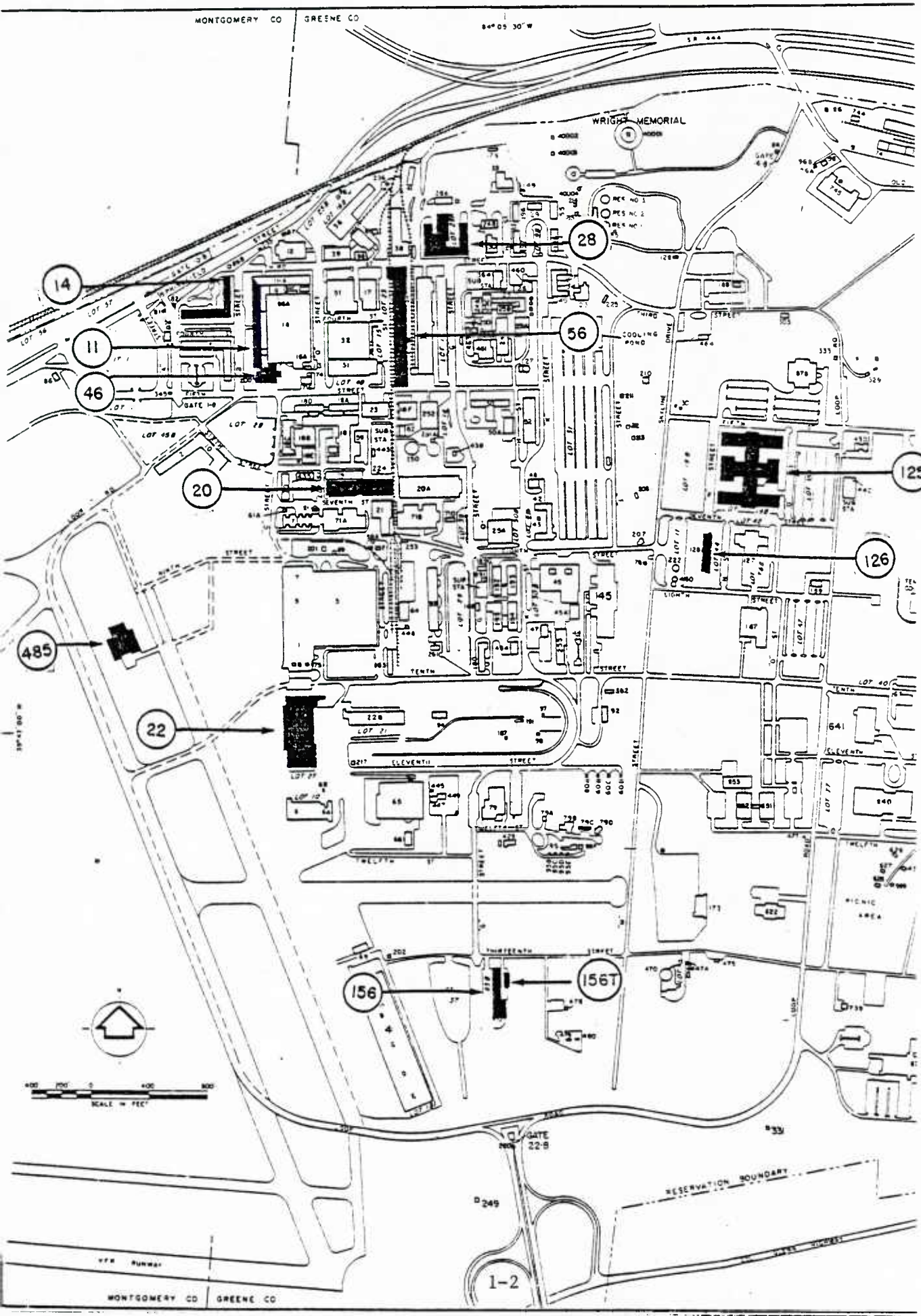
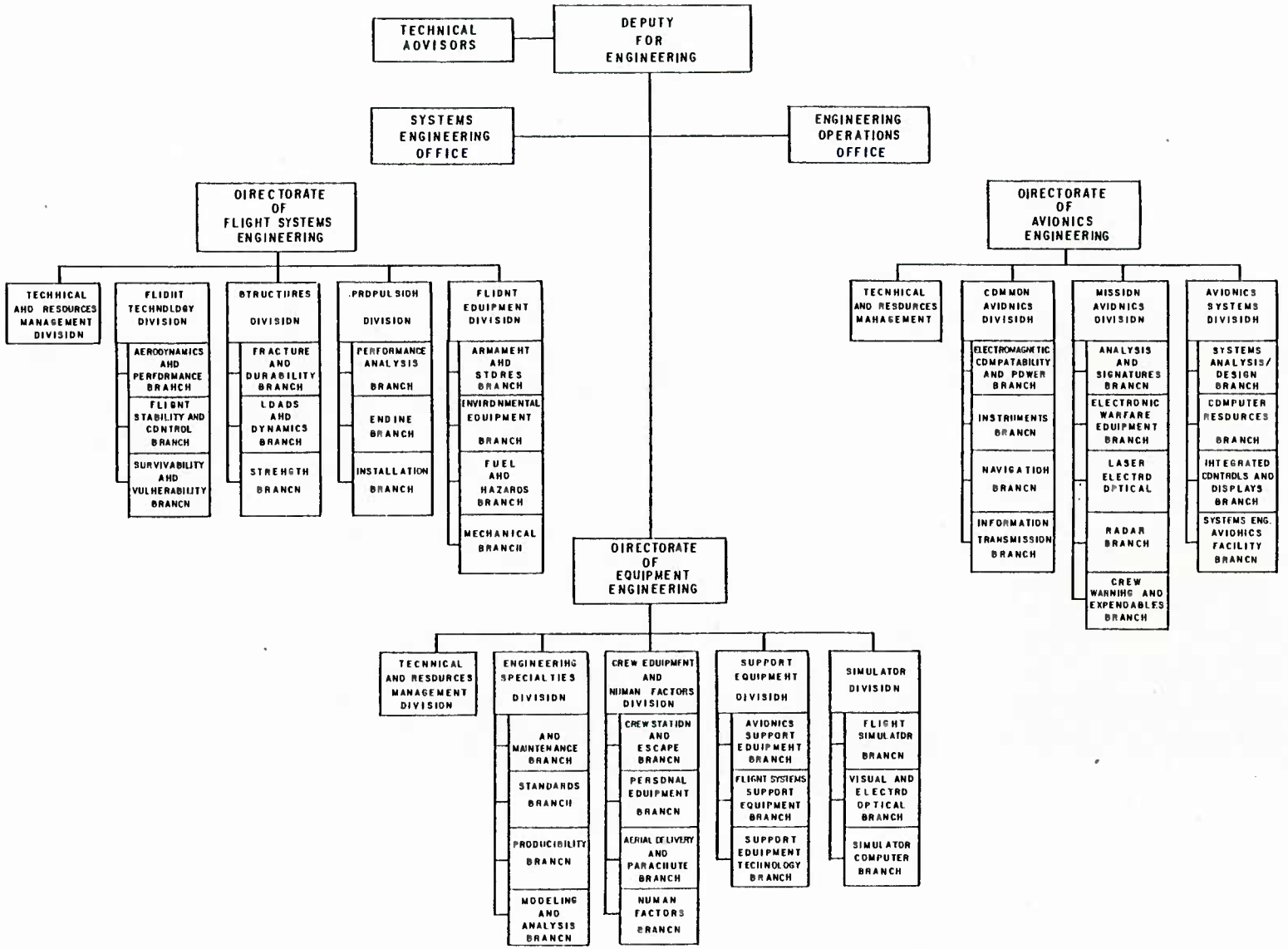


FIGURE 1-2 EN ORGANIZATIONAL STRUCTURE



The Deputy for Engineering tasked the Logistics Management Institute to conduct a three-phase study of their facility requirements. In phase 1 of the study, which this report covers, we review the current and future missions of EN, analyze the communication relationships among EN organizations, identify major existing facilities deficiencies, and assess the impact of these deficiencies on mission accomplishment. Phases 2 and 3 of the study will identify options for eliminating existing facility deficiencies and provide cost-benefit analyses of various alternatives.

We have divided this report of existing EN facilities into two distinct sections: Chapter 2 which provides an analysis of existing EN missions and facilities, and Chapter 3 which considers enhanced mission requirements and the impact of these on facility needs. Chapter 4 summarizes our conclusions.

CHAPTER 2. CURRENT MISSION AND FACILITIES

This chapter describes the current EN mission and assesses the adequacy of existing EN facilities to accomplish this mission. We evaluate EN facilities in terms of space allocation, facility condition, facility dispersion, and adequacy for existing mission.

CURRENT MISSION

The mission of EN is to provide system engineering and technical direction to the SPOs and to provide general engineering support to ASD and others as needed. EN performs system development of all aircraft functions including application of research and development work from the Air Force Laboratories and SPO program development work. The most important phase of EN's mission is its support to SPOs where engineering design and performance tradeoffs are decided. Increasing sophistication of weapon systems, increasing emphasis on systems integration, and rapid changes in technology, all make the accomplishment of EN's mission a dynamic and changing process.

SPACE ALLOCATION

Summary

Net floor area can be categorized as administrative space (office and support) plus special purpose space as defined in the following section. EN occupies 186,357 gross square feet of facilities, of which 151,294 SF is net floor area (106,627 SF of net office area, 9,420 SF of administrative support space, and 35,247 SF of special purpose space). This gives a design ratio (net floor area to gross floor area) of 0.81, which is within the general Air Force guideline range of 0.80 to 0.85.

The quantity of net office space in 44 percent of EN organizations is below the Air Force standards and 84 percent of administrative support space is below standard. Space deficiencies also exist in EN's special purpose space. These are shown to impact EN's existing mission capability.

Space Versus Air Force Standard

Various categories of administrative space and special purpose space are defined in Air Force Manual 86-2 as:

net floor area:	total gross floor area in building minus outside walls, partitions, machinery and elevator space, hallways, stairs, and space unusable for offices.
administrative support space:	support areas include rooms for central files, conferences, storage, mail handling, and reproduction equipment.
net office area:	net floor area less administrative support space.
special purpose space:	special support spaces include test facilities, small auditoriums, training rooms, drafting rooms, electronic data processing (EDP) equipment rooms, and holding space for contract maintenance equipment.

Air Force guidelines for net square footage per building occupant (SF/BO) as applied to R&D facilities are as follows:[1,2]

net floor area:	130 SF/BO (minimum 115 SF/BO)
administrative support space:	50 SF/BO (minimum 25 SF/BO)
net office area:	90 SF/BO (minimum 80 SF/BO)

[1]Calculations of net floor area and net office area per building occupant do not include special purpose space since this space is included in an administrative facility when justified by operational requirements.

[2]Data provided by Requirements-Program Division, Directorate of Engineering Services, Deputy Chief of Staff (Logistics and Engineering) (AF/LEEP), and the Pentagon.

There are no specific guidelines for special purpose space. Within EN, this space consist mainly of test facilities, electronic data processing equipment rooms, and equipment related work areas.

Existing EN space allocation within the various categories, as determined by a questionnaire survey of all 62 organizations, is shown in Table 2-1. A detailed listing of space allocation for each organization is contained in Table A-1, Appendix A. Graphical comparisons of these categories for all EN organizations are shown in Figures 2-1, 2-2, and 2-3.

TABLE 2-1. SPACE ALLOCATION SUMMARY

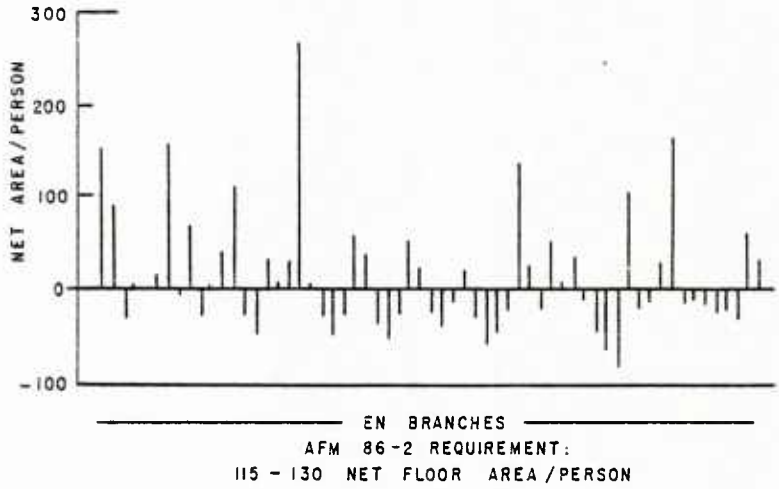
	EN Summary SF/BO*		Percentage of EN Organizations	Percentage of EN Facility Space
	Mean	S.D.		
Net floor area:	139.5	63.0		
Above standard			45	48
Within standard			11	13
Below standard			44	39
Administrative support space:	14.1	30.8		
Above standard			13	52
Within standard			3	20
Below standard			84	28
Net office area:	125.4	44.4		
Above standard			81	85
Within standard			11	10
Below standard			8	5

* Unweighted simple mean of values for 62 EN organization.

Although there are no specific Air Force guidelines for special purpose space, numerous space allocation problems were observed which impact EN's mission capability. These deficiencies are detailed in the next section.

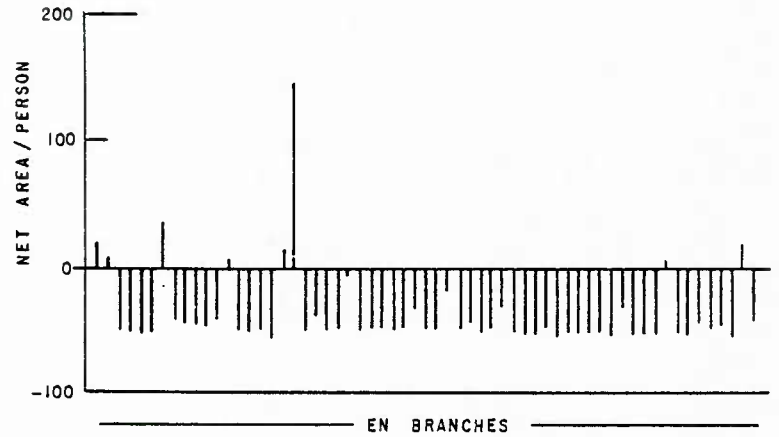
Many of the space problems arise because there are frequent pressures to allocate facility space to one organization at the expense of others.

FIGURE 2-1 NET FLOOR AREA/PERSON OVER/UNDER AF MAXIMUM



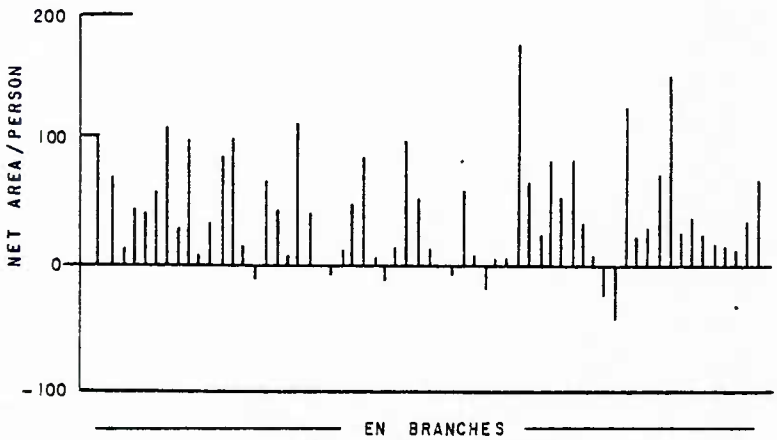
AFM 86-2 REQUIREMENT:
115 - 130 NET FLOOR AREA/PERSON

FIGURE 2-2 NET ADMINISTRATIVE SUPPORT SPACE/PERSON OVER/UNDER AF MAXIMUM



AFM 86-2 REQUIREMENT:
25 - 50 ADMINISTRATIVE SUPPORT SPACE/PERSON

FIGURE 2-3 NET OFFICE AREA/PERSON OVER/UNDER AF MAXIMUM



AFM 86-2 REQUIREMENT:
80 - 90 NET OFFICE AREA/PERSON

The present plan is to "hopscotch" EN organizations as they move out of buildings being renovated and attempt to cluster them into three consolidated areas.

Impact on EN Mission Capability

The major space problems are found in Buildings 156, 485, 20 and 125. Deficient space allocation was found responsible for degraded mission capability in the following instances:

ENA. ENA office space is generally cramped since equipment is often used in office space. Existing space for computers and equipment is only about one-half of what ENA needs. In Building 485 there is no space for the hot bench software maintenance contractor. The contractor is located off-base and requires a tie-in by phone lines. This situation reduces ENA's productivity by increasing down time awaiting maintenance. ENAC in a recent reorganization brought 45 personnel into Building 485, which is now so crowded that some 17 people will have to be moved out. ENAC functions in Building 28 are also being forced out by SPO personnel due to overcrowded storage space for equipment. This relocation will require ENAC to relocate its existing radar ground station to some other special purpose facility with penthouse space. The ENAC function in Building 28 is proposed to move to an off-base site, a move which will further separate ENA personnel. ENACI instruments and cockpit illumination test areas are overcrowded (currently shared with ENASI), causing problems in coordinating its mission tasks by requiring sequential simulations instead of simultaneous operation. In the most recent facility reorganization, ENAM was to be consolidated for the first time in Building 20. But space limitations forced ENAMW to remain in Building 125. Thus a major reason for the reorganization, to improve systems integration by combining offensive and defensive systems within the same facility, has not been accomplished.

ENAMW lacks adequate special purpose space for training of new engineers. ENAMW has generators on the first floor of Building 28 which are needed when flight tests are being run. However, the noise from this arrangement is disruptive to adjacent administrative offices necessitating shorter or rescheduled tests. Scheduling during off-duty hours is not possible since testing must be done when the 4950th Test Wing is airborne. Likewise, the ENAMA computer facility could not be brought to Building 20 because of lack of space and electrical power capacity. ENAMA personnel must travel from Building 20 to Building 125 to use its computer facility.

ENE. ENEG has no place in Building 156 for a proposed new LT2-trainer, a training emulator necessary for ATLAS familiarization. ENEC's space in Buildings 156 and 156T (trailers) is inadequate to house required simulation equipment and personnel. Although renovation of Building 156 is currently underway, the envisioned removal of Building 156T (trailers) will still leave ENE short of space for test and simulation equipment. An existing $3 million FB-111 simulator had to be removed from Building 156 to make room for the new F-16 simulator. FB-111 and F-4 simulators cannot be installed until smaller computers are installed which can fit in the building. ENE personnel require twice the space now allocated to the digital imaging facility to accomplish their mission. Additional simulators (A-10 and B-1) cannot be installed due to space constraints. These simulations will probably be done by the Air Force Aerospace Medical Research Laboratory (AFAMRL), even though it is an ENE mission.

ENF. ENFT, and several other organizations within ENF, need space within EN for classified computer facilities. Presently, personnel must make slow and relatively unproductive batch operation classified runs during a night shift at the Area B computer center (Building 676). Conference areas in

Building 125 are open spaces within large bays. Conferences in these areas are generally disruptive to other people working nearby. ENFE is so crowded that it lacks a conference area, and ENFS uses its conference area both as an office and for meetings.

FACILITY CONDITION

Summary

The quality of existing EN facilities is generally adequate. Major renovations have been undertaken in the last 3 years in Buildings 125, 126, and 156. Some renovations are still needed, especially Building 156.

Condition Versus Air Force Standards

The Air Force real property condition codes define the physical condition and structural adequacy of facilities for meeting current mission requirements. The condition codes are:

Code 1: Usable -- Class A
Generally meets criteria and can house the mission with reasonable maintenance and without major alteration or reconstruction.

Code 2: Usable -- Class B
Upgrading is required and is practical. Although structurally sound, upgrading is required to be classifed Code 1.

Code 3: Force Use
Cannot practically be raised to meet Code 1 standards but, by necessity, must be continued in use for a short duration until a suitable facility can be obtained. Facility cannot be justifiably or economically improved or upgraded.

Code 4: Sterile
Is unqualified for codes 1, 2 or 3, is excess to mission requirement, and is not economically appropriate for disposal.

Codes 5 & 6: Unusable
No longer tenable for any purpose and applied only to vacated facilities.

Condition classifications of existing EN facilities were obtained from the Base Civil Engineering office. Table 2-2 contains a summary of this

information. A detailed listing of facility condition for each organization is contained in Table A-2, Appendix A.

TABLE 2-2. EN FACILITY CONDITION SUMMARY

	Percentage of EN Organizations	Percent of Net Floor Area to EN Total
Code 1:	26	31
Code 2:	69	60
Code 3:	5	9
Code 4:	0	0
Codes 5 & 6:	0	0

Impact on EN Mission Capability

The following organizations were found to have degraded mission capability due to facility condition deficiencies.

ENA. The environmental control system in Building 485 is unreliable and requires constant maintenance and repairs. The combination of computer air conditioning exhaust and unreliable heating/ cooling building environmental control equipment causes extremely hot temperatures within the high bay area. ENAC communications and IFF engineering evaluation facilities located on the third floor of Building 28 have air conditioning maintenance problems, and water leaks through the roof into the electrical conduits, threatening damage to expensive electronic equipment. ENAM offices are in an open bay area of Building 20 and lack partitions. The area is extremely noisy and staff productivity suffers due to disruptions by noise. The air conditioning in Building 20 is not working adequately.

ENE. Building 156 is completely inadequate for the kinds of expensive electronic equipment presently housed in it. The $5.5 million digital

imaging equipment currently being installed is extremely sensitive to environmental controls. A recent failure of a $20,000 power supply board has been attributed to the improper environmental conditions. The potential risk for damaging other very expensive equipment in the future is high. Facility condition deficiencies in Building 156 have been documented by the Base Civil Engineering office.

ENF. Building 125, which houses all of ENF organizations except ENFP, has maintenance problems with the air conditioning and inadequate plumbing in the restrooms occasionally requiring personnel to use facilities in Building 126 which is 100 yards away. This is not just a matter of inconvenience. Significant interruptions in work arise to use those facilities, particularly during inclement or cold weather.

FACILITY DISPERSION

Summary

The distances between the twelve buildings in Area B housing the 62 EN organizations range up to 3 miles. This separation causes problems within the EN organization in terms of personnel time lost in travel, in-person meetings deferred, and technical information not transferred, and other factors. In general, the direct cost of facility dispersion (e.g., unnecessary travel time) is not great. However, the indirect impacts on mission capability (e.g., reduced technology transfer, deferred meetings, lack of face-to-face communication) are significant.

Travel Time

We estimated travel patterns of home-office EN personnel within Area B by a 3-day questionnaire survey of approximately 73% of the EN population. Extrapolating those observed results to the May 1982 assigned level of

797 home-office personnel (906 authorized)[2], resulted in the following travel findings:[3]

- 2,400 round trips per month between EN buildings (equivalent to 1% of work month)
- 933 hours/month spent traveling between buildings ($175,000 annual cost)
- 1,813 hours/month spent traveling to on-base or off-base lunch ($326,400 annual cost)[4]
- 2,965 phone calls per month preferred as trips (21% of total calls)

Figure A-1, in Appendix A, depicts how one-way travel times between EN home-office buildings vary with distance. No correlation was found between the pattern of actual trips or the number of "preferred trip" phone calls and the distance between EN buildings (see Figures A-2 and A-3 in Appendix A). Consequently, based on results of this survey, actual and preferred trip patterns and their sum (total desired trips) are not a function of distance.

An additional survey question asked respondents to identify EN facilities they would prefer to have located nearby. Results by building are shown in Table A-3, in Appendix A. Twenty-four percent of the total number of respondents indicated a preference to be located near another Area B facility.

No correlation was found between total number of telephone calls among home-office EN personnel and distance between EN organizations. Results for total calls are shown in Figure A-4, Appendix A.

A test of the existing on-base mail system determined that mail delivery times are not a function of distance. Results are shown in Figure A-5, Appendix A.

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[2]Vacancies in System Program Offices (SPOs) are counted in home office authorization level.

[3]Excluding travel to SPOs.

[4]This primarily affects personal time of staff.

Impact on EN Mission Capability

A number of studies have shown that organizational communication is effected by distance between individuals. Several studies by Dr. T. J. Allen of the Sloan School of Management indicate that ...

> "over 80 percent of an engineer's ideas arise from face-to-face contact with colleagues. Engineers dislike seeking information on the phone, will not travel more than 100 feet or so from their desks to exchange ideas, even when working in the same building on the same project, and avoid using elevators. Distance decays interaction."[5],[6]

Dr. Allen estimated that a single, centrally located facility incorporating proper communication architectural design, might increase engineering productivity by as much as 15 percent over an existing scattered facility layout. Dr. Allen also found that separation of technical personnel by 140 feet essentially eliminates 90 percent of the possibility of technical communication between them.[7]

Other studies have indicated the importance of internal communication for the performance of project teams, especially applied research engineers.[8] Architectural design of the laboratory space has been shown to effect communication in R&D organizations.[9]

Additional studies indicated that government workers are more sensitive to physical environment manipulation than are private sector workers.

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[5]Fallucchi, A., "Corning Glass Design Spurs Engineers' Creativity," Facilities Design and Management, January 1982, page 43.

[6]"A Meeting of Minds at Corning," Architectural Record, September 1981, page 79.

[7]Roberts, E.B., "Generating Effective Corporate Innovation," Technology Review, October/November 1977, page 29.

[8]"Vive la Difference in R&D Managers," Technology Review, November 1979, page 80.

[9]Barley, S. R., "Architectural Influences on Communication in R&D Labs," conference paper, May 1982.

Job performance, job satisfaction, and environmental satisfaction are directly effected by the work environment and by each other (e.g., the most significant relationship is between job satisfaction and environmental satisfaction).[10]

As examples of these findings, EN personnel strongly believe that dispersion causes functional directorates to become departmentalized, resulting in reduced communication, especially among the technical engineers. This leads to reduced technology transfer from R&D laboratories to EN and eventually to the SPO's. A major function of EN management is higher levels of integration of all aircraft functions, and this effort is frustrated by the lack of personal contact with counterparts in other directorates. The dispersion of EN facilities requires duplication of administrative functions. Dispersion causes increased costs for security, safety, personnel training, and management systems control.

Degraded mission capability due to facility dispersion and communication deficiencies were reported by the following organizations.

ENA. ENA personnel state that physical separation from other directorates and fractionation within ENA has decreased productivity and work quality. For example, ENAMW has ten people in Building 28; however, their branch chief and division chief are in Building 485. To attend administrative staff meetings in Building 485, Building 28 employees must shut down all tests, go to Building 485 and return to Building 28 via base taxi or personal car. Waiting time for the base taxi is reported to be 20 minutes each direction. In addition, personnel in ENAMW feel isolated from the rest of ENAM and not able to contribute to the overall mission. Interdirectorate communication is directly affected. For example, one ENAM branch worked effectively

[10]Personal communication, Buffalo Organization for Social and Technological Innovation, Inc., Buffalo, New York, May 1982.

with ENFTV when both were in Building 125. Since ENAM moved to Building 20, the benefits of this interaction are now essentially lost. ENA management claim that dialog among ENAME, ENAMA and the isolated ENAMW branch is lost, that interdirectorate cross-fertilization is reduced, that morale suffers, and that the amount of technical communication which exists could be enhanced greatly by person-to-person versus written and telephone communications.

ENE. ENE personnel report that facility dispersion causes EN to become departmentalized, resulting in lower productivity and work quality. Examples are numerous. ENEG cannot communicate easily with ENA and ENF. Consequently, some on-board aircraft electrical equipment cannot be tied in with the automatic test equipment. ENEGA is currently developing automatic test equipment for avionics black boxes. Since ENA avionics engineers are "down the hill," ENEGA engineers often do not know their counterparts well or understand their views and requirements. Adaptation of test equipment becomes difficult, resulting in less than an optimal product. There are also not enough ENESR engineers to handle the reliability and maintainability function for all the directorates, and dispersion hinders the existing reliability and maintainability program and training in other directorates. The ENET manager is in Building 11 but spends a significant amount of time traveling to ENETV (in Building 156). Security briefings at one location require inter-building travel by one entire 75-man branch on a recurring basis. As another example, ENEC in Building 156 had a problem with its Central Processing Unit (CPU). One and one-half days were wasted trying to troubleshoot the problem before they finally shut down the CPU, took all the test equipment and boards down to Building 485, and ran the troubleshooting on a hot bench. Several ENE personnel felt that it was very important to have ENE (or a consolidated EN) near the SPOs. For example, ENET has two of three branches in Building 11 collocated with the SPOs (YW) and has reported productivity increases. ENE

personnel state that any future consolidation of EN buildings should keep ENE buildings near the SPO's.

ENF. Although ENFP is isolated from the rest of the directorates, ENF personnel believe that their biggest problem is separation from the SPOs and organizations "down the hill." Similar statements were also made by personnel in ENE and ENA. Their feelings are summarized with this remark: "It would be nice to be in the same building or within walking distance, where you could conveniently get up from your desk and go to a meeting without having to drive your car and circle the building 5 times or park out and walk a mile." The SPO/home-office EN dispersion has always been a major problem, although, apparently less so under the disbanded "skeleton matrix system" where engineers are TDY to the SPOs. ENF has problems communicating with SPO-collocated ENF engineers, especially since the bus system was terminated, and claims that if ENF were located closer to the SPOs a better technical job would result. Productivity increases would result also because of better control of SPO/home-office work by centralized handling in the home-office. ENF needs interdirectorate communication for comparative studies on airplanes (like the F-15/F-16 study) and these require much travel "down the hill." Otherwise most ENF work is with other groups in Building 125. However, ENFTV requires significant interface with avionics and electronic warfare organizations, and their dispersion has caused coordination problems. Finally, the Air Force Laboratories and the technical library are under-utilized because of dispersion.

SUMMARY

In this chapter we evaluated EN's facilities in terms of space allocation, facility condition, facility dispersion, and the effect these have on

EN's existing mission. In general, space allocation is adequate except for administrative support space and special purpose space in specific organizations, e.g., engineering evaluation space. Space condition is generally usable (91 percent is Code 1 or 2), with some exceptions. Facility dispersion is the most disrupting factor, causing time lost due to interbuilding travel, trips to cafeterias, and trips replaced by phone calls. Dispersion also significantly reduces the ability of EN to perform integration, reliability and maintainability, and related mission functions. Mission requirements indicate a need for better quality and more consolidated facilities.

CHAPTER 3. ENHANCED MISSION AND FACILITY REQUIREMENTS

The mission of EN is to provide system engineering and technical direction to the SPOs and to provide general engineering support to ASD and others as needed. Existing EN organization mission statements do not reflect the growing emphasis on systems integration, and existing EN facilities are not configured to provide large-scale systems integration capability. Several new mission requirements are planned for the near future that will necessitate major upgrading and consolidation of ASD and EN functions. A major realignment of the ENS directorate will require additional facilities for 150 new personnel and much more interdirectorate coordination and communication. A new Systems Integration Facility is being planned that will require a realignment of EN facilities. New electronics training facilities also are needed.

NEAR-TERM MISSION CHANGES

ENA

Because of the surge in digital processing and its applications to the flight avionics, the mission of ENA is constantly evolving. The number of ENAS personnel is projected to increase 50 percent of which 35 percent will be in SEAFAC alone. The SEAFAC facility (ENASF) is the primary test facility in ENA. Present and near-term missions include: compliance testing for 1553 data bus standards, computer architecture for 6050 series computers, verification and test certification capability for 32-bit architecture, verification and testing of 1750 series architecture, maintenance of JC higher-level language compilers (requires new VAX computer system), maintenance of ADA (NATO higher-level language), maintenance of J73 higher-level language compilers (presently requires hot bench capability, dedicated VAX computer, IBM computer,

and DEC-10 computer), maintenance of F-16 language compilers, and hardware testing of many new avonics standards.[1] A KC-135 hot bench responsibility for in-house mock-up and trade-off studies has been recently assigned to ENA (a $600 million cost avoidance over contracting for the service) and will require new hot bench capability. A verification and testing capability for electrical interfaces in a standard stores management program will also require new hot bench capability and another VAX computer. ENASF is expanding rapidly into many new areas including computers interacting with engine and flight controls requiring future simulation capability with ENAC, ENFA, and ENFEA. All of these tasks require more facilities. ENASI, in the near future, will have responsibility for the remote map reader system, requiring more hardware. The communications and IFF group (ENAC) has recently built up a capability in the combat identification systems area and needs an in-house laboratory and flight test facility which is presently planned for the Avionics Laboratory and the computer center. ENAM also plans to establish at SEAFAC a simulation capability similar to the AFEWES electronic warfare simulation facility except it will provide concepts testing at EN not operational training and evaluation. In the near future, ENA will need capability to test and exercise the aircraft systems (especially the stores management interface) either inside or nearby the SEAFAC facility. The need for hot benches for the FB-111 could easily expand in a short period of time from the one presently required to ten.

ENE

ENE lacks any facility to train incoming and transfer engineers in the area of automatic test equipment. ENEC's chemical defense laboratory, now

[1]Indicates known near-future mission.

in Building 156, is projected to expand and will require additional facilities. Reliability and maintainability presently are performed only by ENESR, but the hardware systems need more hardware engineering input in this area, and new facilities will be required for this. ENE personnel believe they should be writing good subsystem specifications instead of discrete component-type specifications because of the higher levels of integration among weapon systems. It is felt there must be integration at the support directorate working level, such as now occurs between ENE and SEAFAC. The preferred method of integration is joint working of common problems. The present dislocation of organizations generally precludes this type of solution. For example, if ENE were collocated with ENA, there could be a better matching of man to the instrument displays. Additionally, because of lack of space in Building 156 for ENECH to install needed simulators and equipment, both ENECH and AFAMRL are doing similar crew station design work, even though it is an ENECH mission.

ENF

There is a critical need for close interaction between the engine performance and propulsion installation engineers with internal aerodynamics and aircraft performance engineers. Development of aircraft system performance is a direct function of thrust and drag forces, which entail both throttle dependent and independent terms. These groups of engineers who currently develop the propulsion and aerodynamic data are separated by about one mile, with the propulsion division being located with the Deputy for Propulsion, a functional SPO. Communication and transfer of engine performance decks are severely hampered by this separation. In addition to the logistics difficulty, the synergism afforded by face-to-face communications between propulsion and aerodynamics persons is lost. This is considered to be the most serious problem affecting the Directorate mission.

The role of system software engineers is rapidly expanding with the increased use of digital flight, propulsion and fire control systems. Because software engineers are not normally trained in the flight systems disciplines, a long-term, in-house training program is required. It is planned to expand the software group by about ten persons within the next three years. Consequently, additional home office space is required for these employees, their trainers and the office staff. This will be a continuing requirement.

ENS

ENS needs a high-level security computer vault for its computer analysis. At present, personnel must schedule night runs at the computer center.

NEW ENS DIRECTORATE

Basically, the new ENS mission will be the same as it is now: to provide leadership and direction for systems engineering, technical direction and engineering management support to ASD program offices, the Deputy for Development Planning, and the air vehicle portion of programs assigned to other AFSC divisions. However, the nature of the work will change. New mission requirements will include survivability analysis, effectiveness analysis, trade-off studies, and system development studies which require iterative, continuous input from the functional directorates. The new organization will require more interaction between home-office ENS personnel and the functional directorates than is now occurring.

The new ENS will have 100 to 150 home-office personnel plus the 100 collocated personnel at the SPOs. Current plans are to house this new directorate in Building 127. Since much computer simulation will be done in the new ENS directorate, a new computer facility is needed. Also, since there will be much interdirectorate communication, the new directorate should be physically close to other directorates and to the SPOs.

Since the new ENS will draw together organizations in the functional directorates, some reorganization of the existing functional directorates has been proposed: total authorized strength will be reduced by 70 personnel in ENE and by 47 personnel in ENF. Projections for ENA are not yet determined. If this reorganization does occur, the entire facilities requirement will change accordingly.

SYSTEMS INTEGRATION FACILITY

The proposed systems integrating simulation facility will provide real-time, man-in-the-loop simulation for design, development, and integration of weapons systems and avionics subsystems and will facilitate transition of technology from the laboratory to the field. This flexible simulation capability ($20-$30 million in simulation equipment) will support weapon system concept development and evaluation and system/subsystem design, development, integration and production. Tasks to be performed are: development of avionics requirements, relative mission effectiveness, and mission scenarios; cockpit integration, crew size requirements, man-machine interface, and coordination between contractor and Air Force design engineers. The facility concept will fulfill HQ USAF and AFSC requests for increased ASD simulation of weapon system design.

The facility concept calls for a core facility with centralized simulation support to the directorates, SPOs, and laboratories in Area B. The current 5-year planning document indicates a phased increase in capability from FY86-FY90. The facility will contain multiple cockpits, visual scenes, radar and infra-red sensors, and mission scenarios.

Many of the above capabilities presently exist within EN, but they are limited and overburdened. The creation of the integration facility will consolidate many activities, broaden the capability, and increase the efficiency with which the government utilizes those capabilities.

SUMMARY

The scope of the existing EN mission is rapidly changing from emphasis on discrete systems to one of total integration of all aircraft systems. This change in emphasis will necessitate a reorganization of EN and will exceed the capabilities of present facilities, especially since more inter-organizational communication and expensive, delicate electronic equipment will be required. Growth of the entire EN population, combined with requirements to interface more closely with early development design of weapons systems, cannot be accommodated by existing facilities.

CHAPTER 4. CONCLUSIONS

A thorough review of existing EN facilities and organizations reveals five categories of facility deficiencies:

- Dynamic and changing mission requirements within EN require flexibility in facility requirements and accommodation of unique equipment. New mission requirements, growth, and the subsequent reorganization of EN will require additional space and better quality facilities than presently exist.

- Interdirectorate technical information transfer and innovation are fundamental to the success of EN's mission. Presently their loss or degradation is very significant and due almost entirely to the dispersion of EN facilities.

- Dispersion of organizations within EN and within the directorates creates costs in time lost in personnel traveling, in management control, and other communication-related problems.

- The condition of several facilities is inadequate for the mission to be performed and for the expensive equipment housed in them.

- The floor space in several facilities is not adequate for the engineering evaluation functions occurring within those spaces.

- The potential for avoiding unnecessary costs in SPO related work with properly designed EN facilities and engineering equipment is high. Avoidance of just a few multi-million dollar contractor change proposals would more than pay for the additional cost for eliminating existing facility deficiencies.

We conclude that existing Deputy for Engineering facility deficiencies impede its ability to meet current mission requirements. The situation will grow worse as EN mission requirements expand in the future.

APPENDIX A

FIGURE A-1 TRAVEL TIME vs DISTANCE

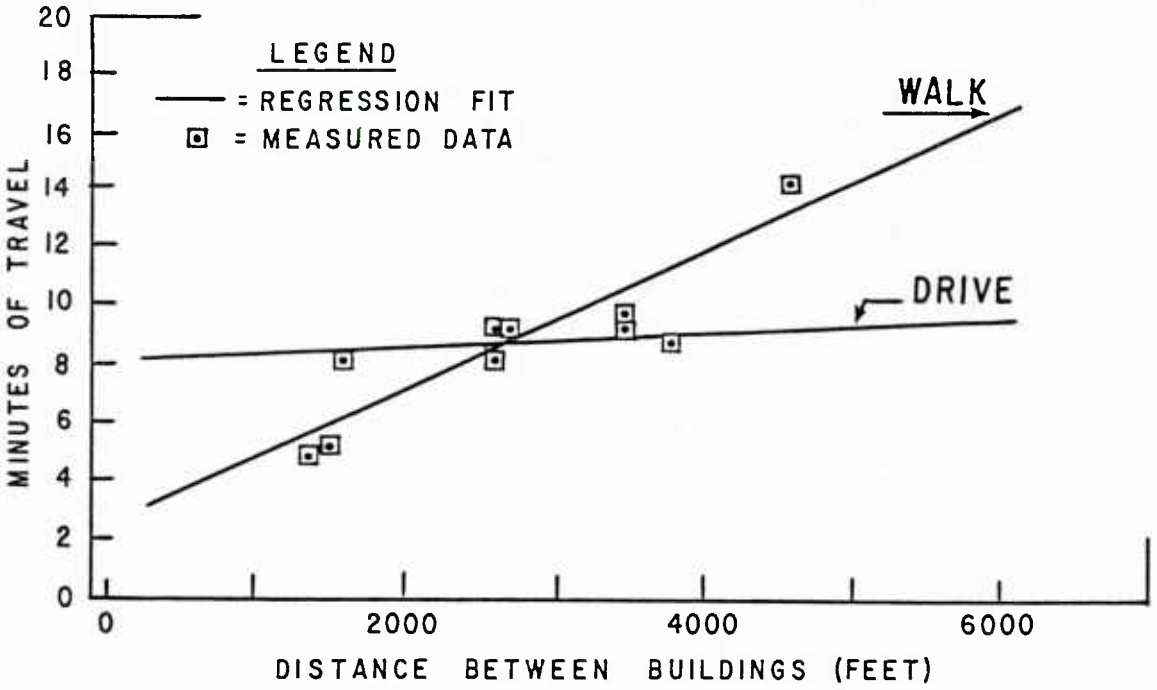

FIGURE A-2 NUMBER OF TRIPS vs DISTANCE

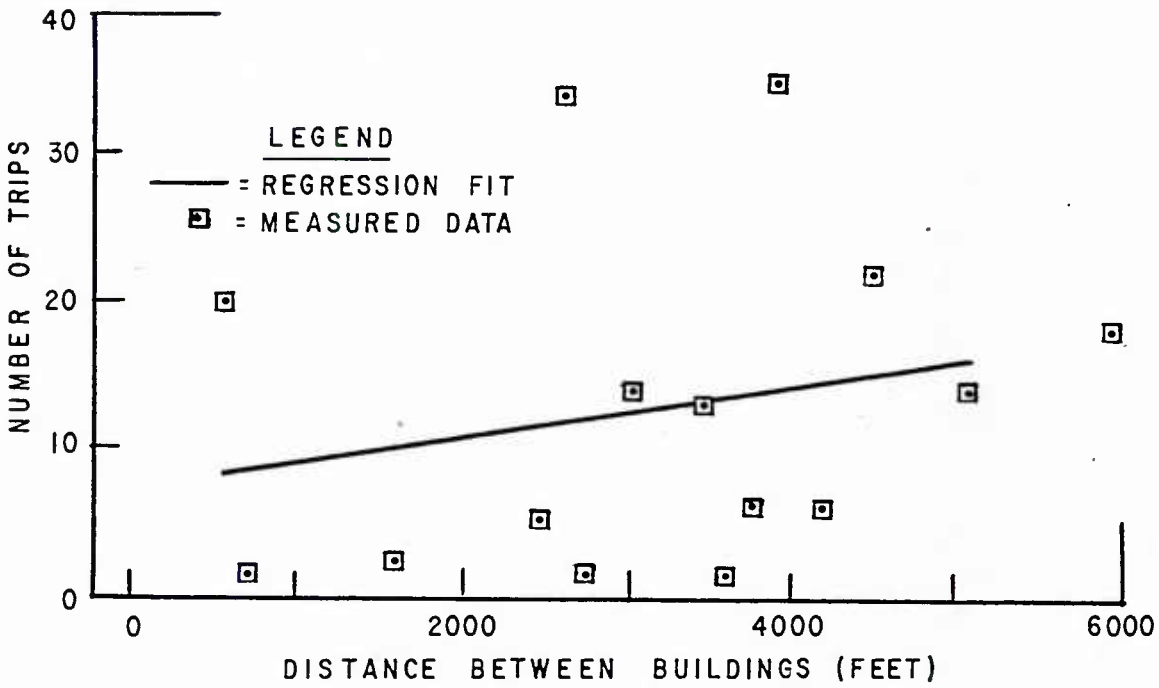

FIGURE A-3 NUMBER OF "PREFERRED VISIT" CALLS vs DISTANCE

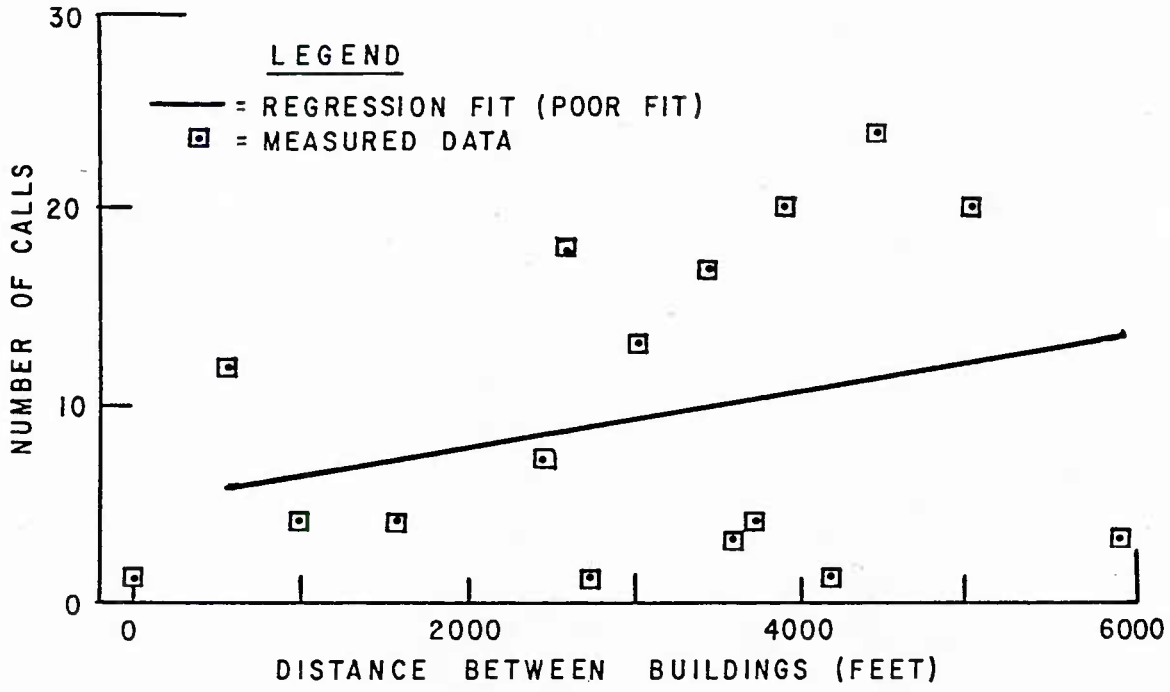

FIGURE A-4 NUMBER OF CALLS vs DISTANCE

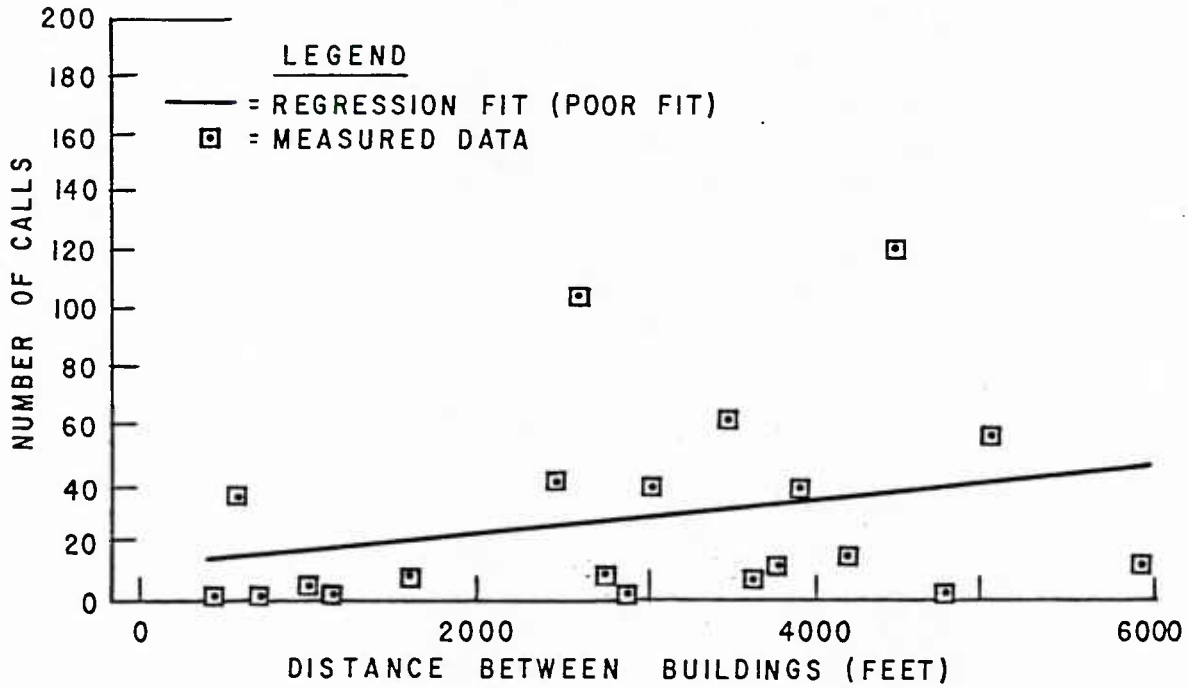

FIGURE A-5 ELAPSED TIME FOR MAIL DELIVERY vs DISTANCE

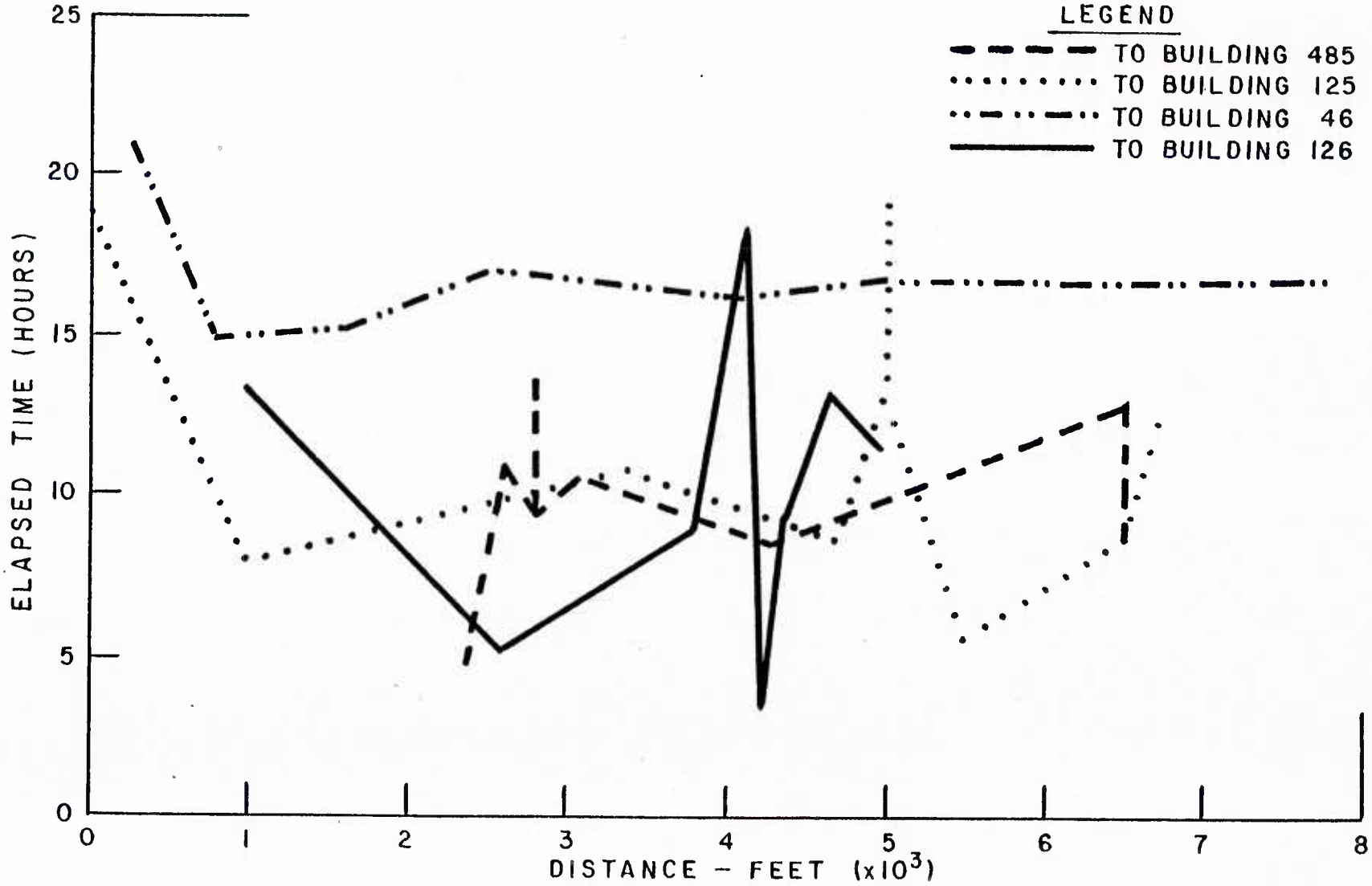

TABLE A-1. SPACE ALLOCATION BY ORGANIZATION

Organization	No. Contractors	No. Authorized Home Office Personnel	Net Office SF/Occup	Net Admin. Support SF/Occup Space	Net Floor SF/Occup	Net Equip SF/Occup	Net Total (Floor + Equip) SF/Occup
ENA	0	7	191.2	70.1	261.4	84.9	346.3
ENAC	0	4	159.5	57.0	216.5	0.0	216.5
ENACE	0	25	102.1	0.0*	102.2*	219.5	321.6
ENACI	0	16	132.6	0.0*	132.6	43.8	176.4
ENACN	0	16	129.3	0.0*	129.3	0.0	129.4
ENACT	4	21	122.2	0.0*	122.2	143.2	265.4
ENAM	0	5	197.8	86.8	284.6	0.0	284.6
ENAMA	0	28	121.1	7.7*	128.8	18.6	147.5
ENAME	0	10	190.2	10.0*	200.2	25.0	225.2
ENAML	0	24	97.2	6.1*	103.4*	72.1	175.4
ENAMR	0	14	124.0	7.1*	131.2	9.3	140.5
ENAMW	0	18	165.5	7.8*	173.3	130.2	303.6
ENAS	0	4	184.0	58.5	242.5	96.3	338.8
ENASA	0	25	105.2	0.0*	105.2*	0.0	105.2
ENASC	0	18	78.7*	0.0*	78.7*	14.4	93.1
ENASF	1	35	155.1	1.9*	157.1	127.5	284.6
ENASI	0	12	129.7	0.0*	129.7	15.8	145.6
ENAZ	0	22	93.1	65.1	158.2	10.2	168.5
ENE	0	5	200.4	191.4	391.8	0.0	391.8
ENEC	0	4	129.2	2.5*	131.7	0.0	131.8
ENECA	0	12	88.6	14.3*	103.0*	0.0	102.9
ENECC	0	11	81.5	0.9*	82.5*	0.0	82.5
ENECE	0	9	102.2	1.1*	103.4*	198.4	301.8
ENECH	21	14	57.0*	18.8*	75.8*	157.7	233.5
ENEG	0	4	163.2	2.5*	165.7	0.0	165.8
ENEGA	0	13	91.2	0.8*	92.0*	0.0	92.0
ENEGF	0	19	76.7	0.5*	77.3*	0.0	77.2
ENEGT	0	10	100.9	1.0*	101.9*	0.0	101.9
ENES	0	3	179.6	3.3*	183.0	0.0	183.0
ENESA	0	11	134.0	17.5*	151.5	26.5	178.1
ENESP	0	11	99.6	0.9*	100.6*	0.0	100.5
ENESR	0	9	87.2	1.1*	88.4*	0.0	88.3
ENESS	0	40	81.9	31.3	113.3*	18.0	131.2
ENET	0	2	145.0	5.0*	150.0	0.0	150.0
ENETC	0	14	90.8	9.3*	100.2*	0.0	100.1
ENETS	0	16	70.7*	0.6*	71.3*	0.0	71.3
ENETV	2	20	76.3*	0.5*	76.7*	98.5	175.2
ENEZ	0	19	83.7	21.4*	105.3*	6.1	111.3
ENF	0	9	264.0	0.0*	264.0	157.8	421.8
ENFE	0	6	153.3	0.0*	153.3	0.0	153.3
ENFEA	0	4	110.0	0.0*	110.0*	0.0	110.0
ENFEE	0	9	171.1	4.4*	175.5	0.0	175.6
ENFEF	0	12	134.3	0.0*	134.3	0.0	134.3
ENFEM	0	14	162.2	0.0*	162.2	0.0	162.3
ENFP	0	4	119.5	0.0*	119.5	0.0	119.5
ENFPA	0	18	84.2	0.0*	84.3*	2.8	87.1
ENFPE	0	12	64.5*	0.0*	64.5*	0.0	64.5
ENFPJ	0	6	45.4*	0.0*	45.4*	0.0	45.3
ENFS	0	6	212.0	20.0*	232.0	0.0	232.0
ENFSF	0	15	108.8	0.0*	108.9*	0.0	108.8
ENFSL	0	20	115.2	0.0*	115.1	0.0	115.2
ENFSS	0	24	155.2	0.0*	155.2	12.0	167.2
ENFT	0	3	238.3	53.3	291.6	0.0	291.7
ENFTA	0	26	114.3	0.0*	114.4*	0.7	115.0
ENFTC	0	22	117.8	0.0*	117.8	0.0	117.8
ENFTV	0	29	108.7	7.6*	116.3	10.9	127.2
ENFZ	0	36	102.4	2.7*	105.2*	34.0	139.1
EN ENO	0	43	101.1	3.5*	104.7*	8.1	112.8
ENS	0	4	100.0	0.0*	100.0*	0.0	100.0
ENSA	0	14	120.0	69.8	189.8	0.0	189.9
ENSG	0	20	151.0	8.5*	159.5	0.0	159.5
	28	906	μ= 125.4 S.D.= 44.4	μ= 14.1 S.D.= 30.8	μ= 139.5 S.D.= 63.0	μ= 28.2 S.D.= 53.8	μ= 167.8 S.D.= 84.3

* = Below Standard.

TABLE A-2. SPACE CONDITION SUMMARY

Organization	Building	Condition Code	Organization	Building	Condition Code	Organization	Building	Condition Code
ENA	485	1	ENECC	126	2	ENFEF	125	2
ENAC	485	1	ENECE	126/156	2/3	ENFEM	125	2
ENACE	485	1	ENECH	126/156	2/3	ENFP	46	1
ENACI	485	1	ENEG	126	2	ENFPA	46	1
ENACN	485	1	ENEGA	126	2	ENFPE	46	1
ENACT	485	1	ENEGF	126	2	ENFPJ	46	1
ENAM	20	2	ENEGT	126	2	ENFS	125	2
ENAMA	20	2	ENES	126	2	ENFSF	125	2
ENAME	20	2	ENESA	126	2	ENFSL	125	2
ENAML	20	2	ENESP	126	2	ENFSS	125	2
ENAMR	20	2	ENESR	126	2	ENFT	125	2
ENAMW	125/28	2/2	ENESS	126	2	ENFTA	125	2
ENAS	485	1	ENET	11	2	ENFTC	125	2
ENASA	485	1	ENETC	11	2	ENFTV	125	2
ENASC	485	1	ENETS	11	2	ENFZ	125	2
ENASF	485	1	ENETV	156/11	3/2	EN	14	2
ENASI	485	1	ENEZ	126	2	ENO	14	2
ENAZ	485	1	ENF	125	2	ENS	125	2
ENE	126	2	ENFE	125	2	ENSA	22	2
ENEC	126	2	ENFEA	125	2	ENSG	56	2
ENECA	126	2	ENFEE	125	2			

TABLE A-3. SURVEY RESULTS OF EN STAFF PREFERENCES FOR BUILDING REALIGNMENT

(Number of responses)

Building Preferred	Building of Respondent: 11	20	46	125	126	156	485
EN Buildings							
11					1	2	
14		1		23	4		7
20				1			9
22	1	1		1			
28		2		1	1		4
46				21			
56				2			1
125		2	4		3		2
126	3			4		3	3
156							1
485		14		7	3	1	
Other							
Area B Buildings							
11					1		
11A		1	1	1			
12	1			8	1		1
16	3	1		12	1	2	3
45				1			1
46				9	1		
50	1			2	2		
52		1		3	1		3
57					5		
167				3			
620							2
653				1			1
SPO (unspecified)				8	6		1
11 (cafeteria)					1		6
11A (travel)	3		1	5			3
20 (canteen)					1		1
22 (tech. library)		1		3	2		
676 (computer center)				2			